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# The global importance of regional studies in marine science: Trans-boundary pollutants matter

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Welcome to the Journal of, *Regional Studies in Marine Science* (RSMA), this is our second editorial providing additional information about our vision for the journal. Even though this journal has a regional focus it is apparent that trans-boundary environmental effects exist for a broad range of pollutants, regardless of the scale at which they are studied.

There are a large number of potential trans-boundary contaminants some of which are commonly acknowledged as pollutants and others whose status is still being debated. Some of the trans-boundary contaminant issues that we would like to see in manuscripts submitted to the journal include: radionuclides, plastics (both large and micro-plastics), contemporary use pesticides and industrial chemicals, oil, pharmaceuticals, nano-particles, climate change related contaminants (e.g. $CH_3$, $CO_2$, $NO_2$, $NO_3$, $H_2S$), nutrients introduced from agriculture and sewage, and Contaminants of Emerging Concern (CECs) including flame retardants and surfactants. Such studies will be particularly welcome where they link levels of contamination to marine biological effects.

***Radionuclides***

One recent widely publicly acknowledged trans-boundary pollution event occurred with the destruction of a portion of the Fukushima Dai-Ichi nuclear power facility as a result of a tsunami that hit the Japanese coastline on March 11, 2011. Three of the six nuclear reactors lost coolant that resulted in the containment vessels being compromised and releasing highly radioactive steam and coolant "waters" (Thakur et al., 2013, Kumamoto et al., 2015). The immediate concern was for the human population in the vicinity of the power plant followed by environmental concerns such as radioactive contamination of adjacent coastal waters where much of the early quantification of radionuclides levels was conducted (Buesseler et al., 2012). Since ocean currents rapidly move large volumes of surface water radionuclides from the accident, such as $^{137}Cs$, have been transported to the North American West coast (Rossi et al., 2013). Thus local events can have regional consequences across boundaries through ocean and atmospheric transport (Marzo, 2014).

***Plastics***

The scientific literature is replete with articles about the disposal of plastic waste locally (e.g., on beaches; Zhao et al., in press) and on regional and global scales; with much discussion of a plastic "gyre" in the Pacific Ocean (Choy and Crazen, 2013). But, a relatively new class of micro-plastic consumer products is now in use in products like hand and face washes. These enter the waste stream and, often, ultimately the oceans. The extent of this pollution in both quantity and spatial extent has not been well documented (Syberg et al., 2015) while their impacts to marine organisms at population level remain largely unknown.

***Pesticides & industrial chemicals***

While it is widely believed that some aspects of the global environmental health have improved because first generation contaminants such as organo-chlorine pesticides (e.g. DDT) and industrial contaminants (e.g. PCBs) have been decreasing in the environment (O'Connor and Lauenstein, 2006, Kimbrough et al., 2008), there are newer contaminants that are being introduced or have been recently introduced into the environment that follow the same basic chemical formulation as the older organo-chlorine contaminants. In particular the group of flame retardants known as polybrominated diphenyl ethers (PBDEs) closely follow the structure of PCBs and even contain the same number of congeners. These compounds and their newer replacements (e.g. polyfluorinated (PFC) compounds) have been introduced into the environment to about the same magnitude as PCBs (Ross et al., 2009) and are now ubiquitous in the environment (Kimbrough et al.,

2009). A portion of the PBDE and PFC congeners exhibit endocrine activity (Johnson et al., 2013). More recently, the mining industries have built long pipes to discharge the mining tailings into deeper waters nearby coral reefs such as those in Coral Triangle (Reichelt-Brushett, 2012). Without knowing hydrodynamics and the fate of these pollutants in such deep waters, it raises an immense environmental concern. As a result this is not just a matter of the oceans being used as waste space but there are potential health consequences to marine biota, and eventually humans who consume contaminated seafood.

***Oil pollution***

Major oil spills from shipping product now occur less frequently because of safety measures that have been adopted by the industry. For instance, ship safety has been improved in many countries as firms require double-hulled vessels to prevent oil spills. However, on the other hand, there is an increased risk from blowouts from ever deeper drilling as oil companies move further and further offshore. Two big oil spills that occurred in the Gulf of Mexico highlight this. Ixtoc I, off of the coast of Mexico, occurred in shallower waters and with the drill string penetrating the sea-bottom to a much smaller extent than the Deepwater Horizon drilling platform. With these newer technologies spills are fewer but when they occur they have the potential to be more significant (Connor, personal communication). This prophetic statement was made the day before the Deepwater Horizon oil spill occurred.

**Pharmaceuticals**

Pharmaceuticals are a contaminant group that is well suited to be studied at the regional level. The world population is ever more reliant on pharmaceuticals and this especially true in the West where an aging population is more dependent on medications. Many of the medications, either as metabolites or the unaltered product, entire the waste-stream and ultimately can be found in urban waterways including rivers and streams and their associated sediments (Choi et al., 2014). In particular, the accumulation of antibiotics' residues and establishment of antibiotic resistant genes in marine microbiota in coastal sediments pose apparently high risks to the ecosystem and human health that are worthy of regional efforts to monitor and manage the situation.

**Nano-particles**

Nano-particles will most likely follow course of so many other contaminants and ultimately be deposited in the World's oceans. Like some of the other contaminants discussed above, first the application of a new technology or product

is developed and then much later the consequences for the unintended marine disposal of these products (e.g. sunscreens comprised of nano titanium oxides and/or nano zinc oxides) becomes apparent.

## Summary

This editorial is a clarion call that trans-boundary pollutants matter since they impact marine life and can also affect people. It is impossible to know what all the possible pollutants that are ultimately arriving in the world's waters are. The ability to "know" what we should be looking for is summarized in an editorial by Scott et al. (2012) who, using Donald Rumsfeld's terminology suggested three categories: Known knowns, Known unknowns, and Unknown unknowns. Listed in the first category are: flame retardants, perfluorinated compounds, and pesticides. The second category includes antibiotics, nano-particles, and transformation products such as the byproducts of water chlorination of treated wastewater effluent. The Unknown unknowns, which are enigmatic, pose the greatest potential danger to environment and is the group for which the most insightful research is possible. Other trans-boundary marine issues (e.g. fisheries exploitation, the spread of pathogens, melting of Arctic ice and the movement of invasive species) we shall leave to later editorials. We hope to receive manuscripts on trans-boundary marine issues and are looking forward to your submissions.

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